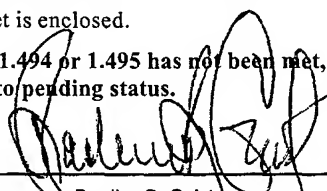


531 Rec'd PCT

11 DEC 2001

BAKER BOTTS LLP		EXPRESS MAIL LABEL No EF377398406US	DATE 12/11/01
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35.U.S.C. 371		ATTORNEY'S DOCKET NO. A34860-PCT-USA	
		U.S. APPLICATION NO. 10/009811 i/b/a	
INTERNATIONAL APPLICATION NO. PCT/DE00/01847	INTERNATIONAL FILING DATE June 7, 2000	PRIORITY DATE CLAIMED June 14, 1999	
TITLE OF INVENTION VOLTAGE INTERMEDIATE CIRCUIT CONVERTER			
APPLICANT(S) FOR DO/EO/US THOMAS GREIF and MATTHIAS SPITZ			
<p>Applicant herewith submits to the United States Designated /Elected Office (DO/EO/US) the following items and other information:</p> <ol style="list-style-type: none">1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.3. <input type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(I).4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))<ol style="list-style-type: none">a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau.c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).<ol style="list-style-type: none">a. <input type="checkbox"/> A copy of the International Search Report (PCT/ISA/210)<ol style="list-style-type: none">a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).b. <input type="checkbox"/> have been transmitted by the International Bureauc. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.d. <input type="checkbox"/> have not been made and will not be made.8. <input checked="" type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). <p>Items 11. to 16. below concern other document(s) or information included:</p> <ol style="list-style-type: none">1. <input checked="" type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409)2. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.3. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.14. <input checked="" type="checkbox"/> A substitute specification.15. <input type="checkbox"/> A change of power of attorney and/or address letter.16. <input type="checkbox"/> Other items or information:<ol style="list-style-type: none">a. <input checked="" type="checkbox"/> a copy of the International Search Report (PCT/ISA/210)b. <input checked="" type="checkbox"/> a copy of the International Preliminary Examination Report (PCT/IPEA/409) <p>Comparison document; English and German versions of application; cover page of PCT international application PCT/DE00/01847; formal drawings (Figs. 1-4); postcard; and check in the amount of \$740.00.</p>			

INTERNATIONAL APPLICATION NO PCT/DE00/01847		INTERNATIONAL FILING DATE June 7, 2000		PRIORITY DATE CLAIMED June 14, 1999	
17. <input type="checkbox"/> The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1)-(5): Neither international preliminary examination fee (37 CFR 1.482) Nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO (1.492(a)(3)) \$1,040 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO (1.492(a)(5)) \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO (1.492(a)(2)) \$740.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) (1.492(a)(1)) \$710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 <div style="text-align: right;">ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 740</div>				CALCULATIONS <small>PTOUSE ONLY</small>	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				\$	
Claims	Number Filed	Number Extra	Rate	\$	
Total Claims	6 -20=	0	X \$ 18.00	\$ 0	
Independent Claims	1 -3=	0	X \$ 84.00	\$ 0	
Multiple dependent claim(s) (if applicable)			+ \$280.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 740	
Reduction by 1/2 for filing by small entity, if applicable.				\$	
SUBTOTAL =				\$ 740	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 740	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$ 740	
				Amt. refunded	\$
				charged	\$
a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>740.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge our Deposit Account No. <u>02-4377</u> in amount of \$_____ to cover the above fees. A copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>02-4377</u> . A copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: Bradley B. Geist BAKER BOTTS L.L.P. 30 Rockefeller Plaza New York, New York 10112-4498					
 Attorney, Bradley B. Geist				PTO Reg: 27,551 12/11/01 Date	

BAKER BOTTS LLP

Attorney Docket Number: A34860-PCT-USA

Title: VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

Use Space Below for Additional Information:

10/009811

A34860-PCT-USA (071308.0283)

PATENT

531 Rec'd PCT/US 11 DEC 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s) : Greif et al.
Serial No. : To Be Assigned
Filed : Herewith
For : VOLTAGE INTERMEDIATE CIRCUIT CONVERTER
Examiner : To Be Assigned
Group Art Unit : To Be Assigned

Assistant Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Kindly amend the above-identified application before examination as follows:

IN THE SPECIFICATION:

Please substitute the originally-filed specification with the Substitute Specification which is enclosed herewith. A comparison document showing the differences between the translation of the originally-filed specification and the enclosed Substitute Specification is also enclosed herewith.

IN THE CLAIMS:

Please amend original claims 1-6 as follows:

1. (Amended) A voltage intermediate circuit converter comprising a 12-pulse input converter having two converter elements, a voltage intermediate circuit having two capacitors connected electrically in series, and a machine-side three-point pulse-controlled converter, wherein the two converter elements are electrically conductively connected on a DC-side to a capacitor in the voltage intermediate circuit, and wherein the converter elements have a self-commutated pulse-controlled converter.
2. (Amended) The voltage intermediate circuit converter according to claim 1, wherein the self-commutated pulse-controlled converters are each three-point pulse-controlled converters.
3. (Amended) The voltage intermediate circuit converter according to claim 1, wherein each capacitor in the voltage intermediate circuit is split, with one capacitor being associated with the machine-side three-point pulse-controlled converter, and two capacitors being associated with a pulse-controlled converter in the input converter.
4. (Amended) The voltage intermediate circuit converter according to claim 1, further comprising a number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter and a number of series-connected active converter devices in the machine-side three-point pulse-controlled converter, said number of active converter devices in the self-commutated pulse-

controlled converter being equal to the number of active converter devices in the machine-side three-point pulse-controlled converter.

5. (Amended) The voltage intermediate circuit converter according to claim 4, wherein the number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter is one less than the number of series-connected active converter devices in the machine-side three-point pulse-controlled converter.

6. (Amended) The voltage intermediate circuit converter according to claim 4, wherein high-voltage insulated gate bipolar transistors are provided as active converter devices of the self-commutated pulse-controlled converters in the input converter and in the machine-side three-point pulse-controlled converter.

REMARKS

By this Preliminary Amendment, applicants amend originally-filed claims 1-6 to comply with the U.S. Patent and Trademark Office practice and standards. No new matter has been added to the application. Amendments to the claims do not address any issues of patentability, and the amended claims are provided to place the application in better condition for allowance.

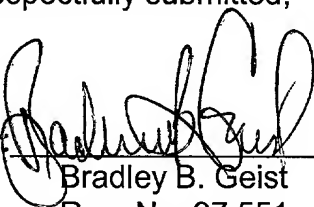
Likewise, the amendments to the specification are provided to correct grammatical and syntactical errors in the originally filed application. No new matter has been introduced into the application.

The amendments to the "Claims" are reflected in the attached "Version With Marked Changes Made."

Favorable consideration on the merits is respectfully requested.

Respectfully submitted,

Dated: December 11, 2001

By: 
Bradley B. Geist
Reg. No. 27,551

BAKER BOTTS L.L.P.
30 Rockefeller Plaza, 44th floor
New York, New York 10112-0228
(212) 408-2562

Version With Marked Changes Made~~We~~WE ~~Claim:~~CLAIM:

1. A voltage intermediate circuit converter ~~having~~comprising a 12-pulse input converter ~~which~~
~~hashaving~~ two converter elements, ~~having~~ a voltage intermediate circuit ~~which hashaving~~ two
capacitors ~~which are connected electrically in series, and having~~ a machine-side three-point
pulse-controlled converter (14), ~~with~~wherein the two converter elements ~~of the input converter~~
~~beingare~~ electrically conductively connected on the DC-side to a respective capacitor in the
voltage intermediate circuit, ~~characterized in that~~and wherein the converter elements ~~of the input~~
converter have a respective self-commutated pulse-controlled converter.
2. The voltage intermediate circuit converter ~~as claimed in~~according to claim 1, ~~characterized in~~
~~that~~wherein the self-commutated pulse-controlled converters are each three-point pulse-
controlled converters.
3. The voltage intermediate circuit converter ~~as claimed in claims 1 and 2, characterized in~~
~~that~~according to claim 1, wherein each capacitor in the voltage intermediate circuit is split ~~such~~
~~that, with~~ one capacitor ~~isbeing~~ associated with the machine-side three-point pulse-controlled
converter, and two capacitors ~~arebeing~~ associated with a pulse-controlled converter in the input
converter.
4. The voltage intermediate circuit converter ~~as claimed in one of the above mentioned claims,~~
~~characterized in that~~according to claim 1, further comprising a number of series-connected
active converter devices in the self-commutated pulse-controlled converters in the input converter
~~is~~and a number of series-connected active converter devices in the machine-side three-point
pulse-controlled converter, said number of active converter devices in the self-commutated pulse-

controlled converter being equal to the number of series-connected active converter devices in
the machine-side three-point pulse-controlled converter.

5. The voltage intermediate circuit converter as ~~claimed in one of claims 1 to 3, characterized in~~
~~that~~according to claim 4, wherein the number of series-connected active converter devices in the
self-commutated pulse-controlled converters in the input converter is one less than the number of
series-connected active converter devices in the machine-side three-point pulse-controlled
converter.

6. The voltage intermediate circuit converter as ~~claimed in one of the above mentioned~~
~~claims, characterized in that~~according to claim 4, wherein high-voltage insulated gate bipolar
transistors are provided as active converter devices of the self-commutated pulse-controlled
converters in the input converter and in the machine-side three-point pulse-controlled converter.

2005.09.14 10:05:41

BAKER BOTTS L.L.P

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NEW YORK, NEW YORK 10112

TO ALL WHOM IT MAY CONCERN:

Be it known that WE, TOMAS GREIF and MATTHIAS SPITZ, citizens of Germany, whose post office addresses are Muehlleite 4, 91341 Roettenbach, Germany; and Buchleithe 53, 91086 Aurachtal, Germany; respectively, have made an invention in:

VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

of which the following is a

SUBSTITUTE SPECIFICATION

FIELD OF THE INVENTION

[0001] The invention relates to a voltage intermediate circuit converter having a 12-pulse input converter, a voltage intermediate circuit and a machine converter using three-point switching.

BACKGROUND OF THE INVENTION

[0002] A converter of the type described above is disclosed in the German magazine "etz", Issue 20, 1998, pages 10 to 12. This voltage intermediate circuit converter has, in its standard version, a 12-pulse diode rectifier, wherein the diode rectifier elements are each connected to a secondary winding of a three-winding transformer. On the DC-

side, the diode rectifier elements are each linked to a capacitor in a voltage intermediate circuit, which has two capacitors which are connected electrically in series. Such an input converter is referred to as a diode front end (DFE). In most cases, such a diode front end satisfies the requirements for the mains system power factor and harmonic content. If mains feedback effects are subject to more stringent requirements, then a 24-pulse input converter is available.

[0003] A voltage intermediate circuit converter which has a self-commutated pulse-controlled converter as the input converter is described in the German magazine "Engineering and automation", Issue 1-2, 1998, pages 8 and 9. Like the machine-side pulse-controlled converter, this input converter is in the form of a three-point pulse-controlled converter. The voltage intermediate circuit is formed by two capacitors which are electrically connected in series. This input converter circuit option is also referred to as an active front end (AFE). An active front end allows four-quadrant operation (driving and regenerative braking in both rotation directions). This active input converter not only allows a power factor of $\cos \varphi = 1$ to be achieved, but also allows the wattless component of other loads to be compensated for in the mains system, at least as far as power margins are concerned. If the active front end is equipped with an input filter, virtually harmonic-free operation from the mains system is also possible.

[0004] A diode front end has the disadvantage that four-quadrant operation is not possible without further complexity. The additional complexity is that a break chopper is required for generator operation, by means of which the generated energy is converted into heat in a breaking resistance. The use of 12-pulse and 24-pulse diode front ends

means that 5th, 7th, 11th and 13th harmonics, and 5th, 7th, 13th, 23rd and 25th harmonics, respectively, are suppressed. In the 24-pulse embodiment of the diode front end, the complexity on the input side is twice that of the 12-pulse embodiment of the diode front end, which means that it is not just the space requirement that increases.

[0005] An active front end has the disadvantage that the 5th, 7th, 11th and 13th, etc. harmonics occur, depending on the number of pulses, the amplitudes of which can at least be minimized by means of an optimized pulse pattern. Furthermore, the active front end is more complex than a diode front end owing to the number and configuration of the components. Since, in design terms, the active front end corresponds to the machine-side self-commutated pulse-controlled converter, a voltage intermediate circuit converter with an active front end occupies a larger amount of space than a voltage intermediate circuit converter with a 12-pulse diode front end.

SUMMARY OF THE INVENTION

[0006] The present invention is based on the object of specifying a voltage intermediate circuit converter having an input converter designed so that the harmonics which occur on the mains system side are kept as low as possible, and with minimal complexity.

[0007] Since the converter elements of the 12-pulse input converter are each self-commutated pulse-controlled converters, the advantages of a diode front end are combined with those of an active front end. This means that the harmonic currents of the 5th, 7th, 17th and 19th harmonics are suppressed on the mains system side of the voltage intermediate circuit converter without the optimized pulse patterns of the self-commutated

pulse-controlled converters being optimized to these harmonics. Since the two converter elements are in the same operating state, their pulse patterns are the same. This optimized pulse pattern can now be optimized such that the amplitudes of the harmonic currents of the 11th, 13th, 25th, etc. harmonics are minimized.

[0008] A further advantage of this input converter according to the present invention is evident at very high voltages. The converters for standard medium voltages have two or more active converter devices connected in series for a voltage value above 3.3 kV. Since the input converter according to the invention has two identical self-commutated pulse-controlled converters, which are connected electrically in series, the number of converter elements connected in series is equal to or one less than the number of machine converters connected in series. With the standard medium voltage of 4.16 kV, the input converter of a voltage intermediate circuit converter according to the invention has precisely the same number of active converter devices as an input converter in the active front end configuration. Low blocking-capability semiconductor switches, which can be operated at a higher switching frequency or can be used at higher current levels, can be used as the active conductor devices, with precisely the same number connected in series. The design of the phase modules is both simple and space-saving, with the number of items connected in series being reduced by one.

BRIEF DESCRIPTION OF THE DRAWING

[0009] The present invention is described in greater detail in connection with the drawings which schematically show an embodiment of the input converter, and in which:

Figure 1 illustrates a block diagram of a standard version of a voltage intermediate converter;

Figure 2 illustrates a block diagram of an input converter according to the invention for a voltage intermediate circuit converter as shown in Figure 1; and

Figures 3-5 each illustrate one phase module of a machine converter of a voltage intermediate circuit converter with 1, 2 and 3 items connected in series.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Figure 1 shows a block diagram of a standard version of a voltage intermediate circuit converter of a generic type with a 12-pulse input converter 2. The two converter elements 4 and 6 of this input converter 2 are each 6-pulse diode rectifiers. Each converter element 4 or 6 is linked on the DC-side to a respective capacitor 8 or 10 in a voltage intermediate circuit 12. Since these two capacitors 8 and 10 are connected electrically in series, this voltage intermediate circuit 12 has three potentials C, M and D. Furthermore, this voltage intermediate circuit converter has a machine converter 14 with the AC-side outputs R, S, T being connected to a three-phase machine 16. On the DC-side, the machine converter 14 is electrically conductively connected to the three potentials C, M and D of the voltage intermediate circuit 12. High-voltage insulated gate bipolar transistors (HV-IGBTs) are provided as active converter devices for the machine converter 14. The machine converter 14 uses three-point switching. The converter elements 4 and 6 of the input converter 2 are electrically conductively connected on the AC-side to a secondary winding 18 or 20 of a three-winding transformer 22. On the primary side, this three-winding transformer 22 is linked to a three-phase mains system 24.

[0011] Figure 2 shows a block diagram of an embodiment of the input converter 2 of the present invention. This input converter 2 has respective self-commutated pulse-controlled converters 4_1 and 6_1 as the converter elements 4 and 6, respectively. These two pulse-controlled converters 4_1 and 6_1 use three-point switching in the same way as the machine-side three-point pulse-controlled converter 14, with HV-IGBTs likewise being used as the active converter devices. On the AC-side, the connections U1, V1, W1 of the self-commutated pulse-controlled converter 4_1 are linked to the secondary winding 18 of the three-winding transformer 22. On the AC-side, the connections U2, V2, W2 of the self-commutated pulse-controlled converter 6_1 are connected to the secondary winding 20 of the three-winding transformer 22.

[0012] Figure 2 also shows the voltage intermediate circuit 12 in more detail. The two capacitors 8 and 10 of this voltage intermediate circuit 12 are each subdivided into three capacitor elements $8_1, 8_2, 8_3$ and $10_1, 10_2, 10_3$. In this case, the two capacitor elements $8_2, 8_3$ and $10_2, 10_3$ are connected electrically in series, and this series circuit is then connected electrically in parallel with the respective capacitors 8_1 and 10_1 . The junction point between the two series-connected capacitors $8_2, 8_3$ and $10_2, 10_3$ form a medium-voltage potential M1 or M2, respectively, for the respective three-point pulse-controlled converters 4_1 and 6_1 . These two series circuits of capacitor elements $8_2, 8_3$ and $10_2, 10_3$ are also connected electrically in series. The junction point between these two series circuits is connected to the central voltage M of the voltage intermediate circuit 12. Since the capacitors 8 and 10 in the voltage intermediate circuit 12 are each subdivided into a number of capacitor elements $8_1, 8_2, 8_3$ and $10_1, 10_2, 10_3$, the capacitor elements 8_1

and 10₁ can be physically associated with the machine converter 14, and the capacitor elements 8₂, 8₃ and 10₂, 10₃ can be physically associated with the self-commutated pulse-controlled converter 4₁, 6₁ in the input converter 2.

[0013] Figure 3 shows a phase module of the machine converter 14, which has four active converter devices T1, T2, T3 and T4 using three-point switching. Each active converter device T1 to T4 has only one semiconductor switch, in particular an HV-IGBT. The number of series connected items in this embodiment is therefore one. This phase module can accommodate a maximum DC voltage U_{ZK} of 3.8 kV between its DC potentials C and D. This DC voltage U_{ZK} is produced by the input converter 2. Since the two converter elements 4₁ and 6₁ are identical and are connected electrically in series on the DC-side, each converter element 4₁ and 6₁ produces half the intermediate circuit voltage U_{ZK} , amounting to 1.9 kV. However, since the phase module has twice the withstand voltage, low blocking-capability semiconductor switches can be used, in comparison to the phase module of the machine-side three-point pulse-controlled converter 14. These low blocking-capability HV-IGBTs can be operated at a higher switching frequency, or at a higher current level.

[0014] Figure 4 shows a phase module, whose active converter devices T1 and T4 each have two semiconductor switches, in particular HV-IGBTs. In this case, the number of items connected in series is two (2). A maximum DC voltage U_{ZK} of 6.8 kV can occur between the DC potentials C and D. In a voltage intermediate circuit converter as shown in Figure 1, and having an input converter 2 according to the invention, the phase modules of the machine-side three point pulse-controlled converter 14 are designed as shown in

Figure 4, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 3.

[0015] Figure 5 shows a phase module in which the active converter devices T1 to T4 each have three semiconductor switches, in particular HV-IGBTs. The number of these active converter devices connected in series is three. In this phase module, with three items connected in series, it is possible for a maximum DC voltage U_{ZK} of 10 kW to be dropped between or across the potentials C and D. In a voltage intermediate circuit converter for a standard medium voltage of 6 kV, the phase modules of the machine converter 14 are designed as shown in Figure 5, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 4.

[0016] The number of items connected in series in the converter elements 4_1 and 6_1 in comparison to the number of items connected in series in the machine converter 14 is thus one less beyond a standard medium voltage of 3.3 kV. The phase modules of the converter elements 4_1 and 6_1 are therefore less complex than the phase modules in the machine converter 14. In a voltage intermediate circuit converter for the medium voltage of 4.16 kV, the number of semiconductor switches in the two converter elements 4_1 and 6_1 in the input converter 2 is equal to the number of semiconductor switches in the input converter 2 in the active front end embodiment. This means that, 5th, 7th, 17th and 19th harmonics are eliminated just by the circuitry, and without having to increase the number of semiconductor switches.

BAKER BOTTS L.L.P

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VOLTAGE INTERMEDIATE CIRCUIT CONVERTER

of which the following is a

SPECIFICATION

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The invention relates to a voltage intermediate circuit converter ~~as claimed in the~~
~~precharacterizing clause of claim 1.~~ having a 12-pulse input converter, for a voltage
intermediate circuit converter and a machine converter using three-point switching.

BACKGROUND OF THE INVENTION

[0002] A converter ~~such as this is known from~~ of the type described above is disclosed in
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intermediate circuit converter has, in ~~the~~its standard version, a 12-pulse diode rectifier, ~~whose~~wherein the diode rectifier elements are each connected to a secondary winding of a three-winding transformer. On the DC-side, the diode rectifier elements are each linked to a capacitor in a voltage intermediate circuit, which has two capacitors which are connected electrically in series. Such an input converter is also referred to as a diode front end (DFE). In most cases, such a diode front end satisfies the requirements for the mains system power factor and harmonic content. If mains feedback effects are subject to more stringent requirements, then a 24-pulse input converter is available.

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for generator operation, by means of which the generated energy is converted into heat in a breaking resistance. The use of 12-pulse and 24-pulse diode front ends means that 5th, 7th, 11th and 13th harmonics, and 5th, 7th, 13th, 23rd and 25th harmonics, respectively, are suppressed. In the 24-pulse embodiment of the diode front end, the complexity on the input side is twice that of the 12-pulse embodiment of the diode front end, which means that it is not just the space requirement that increases.

[0005] An active front end has the disadvantage that the 5th, 7th, 11th and 13th, etc. harmonics occur, depending on the number of pulses, ~~whose~~the amplitudes, of which can at least be minimized by means of an optimized pulse pattern. Furthermore, the active front end is more complex than a diode front end owing to the number and configuration of the components. Since, in design terms, the active front end corresponds to the machine-side self-commutated pulse-controlled converter, a voltage intermediate circuit converter with an active front end occupies a larger amount of space than a voltage intermediate circuit converter with a 12-pulse diode front end.

SUMMARY OF THE INVENTION

[0006] The present invention is ~~now~~ based on the object of specifying a voltage intermediate circuit converter ~~whose~~having an input converter is designed ~~such~~so that the harmonics which occur on the mains system side are kept as low as possible, and with ~~little~~minimal complexity.

~~[0007] ——— This object is achieved according to the invention by the characterizing features of claim 1.~~

[0007] ~~[0008]~~ Since the converter elements of the 12-pulse input converter are each self-commutated pulse-controlled converters, the advantages of a diode front end are combined with those of an active front end. This means that the harmonic currents of the 5th, 7th, 17th and 19th harmonics are suppressed on the mains system side of the voltage intermediate circuit converter without the optimized pulse patterns of the self-commutated pulse-controlled converters being optimized to these ~~said~~ harmonics. Since the two converter elements are in the same operating state, their pulse patterns are the same. This optimized pulse pattern can now be optimized such that the amplitudes of the harmonic currents of the 11th, 13th, 25th, etc. harmonics are minimized.

[0008] ~~[0009]~~ A further advantage of this input converter according to the present invention ~~for a voltage intermediate circuit converter~~ is evident at very high voltages. The converters for standard medium voltages have two or more active converter devices connected in series for a voltage value above 3.3 kV. Since the input converter according to the invention has two identical self-commutated pulse-controlled converters, which are connected electrically in series, the number of converter elements connected in series is equal to or one less than the number of machine converters connected in series. With the standard medium voltage of 4.16 kV, the input converter of a voltage intermediate circuit converter according to the invention has precisely the same number of active converter devices as an input converter in the active front end configuration. Low blocking-capability semiconductor switches, which can be operated at a higher switching frequency or can be used at higher current levels, can be used as the active conductor devices, with precisely the same number connected in series. The design of the phase modules is

~~simpler~~both simple and more space-saving, with the number of items connected in series being reduced by one.

~~[0010] ——— Advantageous embodiments of the input converter can be found in the dependent claims 2 to 6.~~

BRIEF DESCRIPTION OF THE DRAWING

~~[0009] ——— [0011] In order to explain the~~The present invention is described in moregreater detail, reference should be made to in connection with the drawing, drawings which shows ~~one~~schematically show an embodiment of the input converter according to the invention, schematically, and in which:

Figure 1 ~~shows~~illustrates a block diagram of a standard version of a voltage intermediate converter of this generic type;

Figure 2 ~~shows~~illustrates a block diagram of an input converter according to the invention for a voltage intermediate circuit converter as shown in Figure 1; and

Figures 3-5 each ~~show~~illustrate one phase module of a machine converter of a voltage intermediate circuit converter with 1, 2 and 3 items connected in series.

DETAILED DESCRIPTION OF THE INVENTION

~~[0010] ——— [0012]~~ Figure 1 shows a block diagram of a standard version of a voltage intermediate circuit converter of ~~this~~a generic type with a 12-pulse input converter 2. The two converter elements 4 and 6 of this input converter 2 are each 6-pulse diode rectifiers. Each converter element 4 or 6 is linked on the DC-side to a respective capacitor 8 or 10 in a voltage intermediate circuit 12. Since these two capacitors 8 and 10 are connected

electrically in series, this voltage intermediate circuit 12 has three potentials C, M and D. Furthermore, this voltage intermediate circuit converter has a machine converter 14, to whose 14 with the AC-side outputs R, S, T being connected to a three-phase machine 16 is ~~connected-16.~~ On the DC-side, ~~this~~the machine converter 14 is electrically conductively connected to the three potentials C, M and D of the voltage intermediate circuit 12. High-voltage insulated gate bipolar transistors (HV-IGBTs) are provided as active converter devices for the machine converter 14. The machine converter 14 uses three-point switching. The converter elements 4 and 6 of the input converter 2 are electrically conductively connected on the AC-side to a ~~respective~~-secondary winding 18 or 20 of a three-winding transformer 22. On the primary side, this three-winding transformer 22 is linked to a three-phase mains system 24.

[0011] ~~[0013]~~ Figure 2 shows a block diagram of an ~~advantageous~~-embodiment, ~~according to of the input converter 2 of the present invention, of an input converter 2.~~ This input converter 2 has respective self-commutated pulse-controlled converters 4₁ and 6₁ as the converter elements 4 and 6, respectively. These two pulse-controlled converters 4₁ and 6₁ use three-point switching in the same way as the machine-side three-point pulse-controlled converter 14, with HV-IGBTs likewise being used as the active converter devices. On the AC-side, the connections U₁, V₁, W₁ of the self-commutated pulse-controlled converter 4₁ are linked to the secondary winding 18 of the three-winding transformer 22. On the AC-side, the connections U₂, V₂, W₂ of the self-commutated pulse-controlled converter 6₁ are connected to the secondary winding 20 of the three-winding transformer 22.

[0012] ~~{0014}~~ This illustration in Figure 2 also shows the voltage intermediate circuit 12 in more detail. The two capacitors 8 and 10 of this voltage intermediate circuit 12 are each subdivided into three capacitor elements 8_1 , 8_2 , 8_3 and 10_1 , 10_2 , 10_3 . In this case, the two capacitor elements 8_2 , 8_3 and 10_2 , 10_3 are connected electrically in series, and this series circuit is then connected electrically in parallel with the respective capacitors 8_1 and 10_1 . The junction point between the two series-connected capacitors 8_2 , 8_3 and 10_2 , 10_3 form a medium-voltage potential M1 or M2, respectively, for the respective three-point pulse-controlled converters 4_1 and 6_1 . These two series circuits of capacitor elements 8_2 , 8_3 and 10_2 , 10_3 are also connected electrically in series. The junction point between these two series circuits is connected to the central voltage M of the voltage intermediate circuit 12. Since the capacitors 8 and 10 in the voltage intermediate circuit 12 are each subdivided into a number of capacitor elements 8_1 , 8_2 , 8_3 and 10_1 , 10_2 , 10_3 , the capacitor elements 8_1 and 10_1 can be physically associated with the machine converter 14, and the capacitor elements 8_2 , 8_3 and 10_2 , 10_3 can be physically associated with the self-commutated pulse-controlled converter 4_1 , 6_1 in the input converter 2.

[0013] ~~{0015}~~ Figure 3 shows a phase module of the machine converter 14, which has four active converter devices T1, T2, T3 and T4 using three-point switching. Each active converter device T1 to T4 has only one semiconductor switch, in particular an HV-IGBT. The number of series connected items in this embodiment is therefore one. This phase module can accommodate a maximum DC voltage U_{ZK} of 3.8 kV between its DC potentials C and D. This DC voltage U_{ZK} is produced by the input converter 2. Since the

two converter elements 4_1 and 6_1 are identical and are connected electrically in series on the DC-side, each converter element 4_1 and 6_1 produces half the intermediate circuit voltage U_{ZK} , amounting to 1.9 kV. However, since the phase module has twice the withstand voltage, low blocking-capability semiconductor switches can be used, in comparison to the phase module of the machine-side three-point pulse-controlled converter 14. These low blocking-capability HV-IGBTs can be operated at a higher switching frequency, or at a higher current level.

[0014] ~~[0016]~~ Figure 4 shows a phase module, whose active converter devices T1 and T4 each have two semiconductor switches, in particular HV-IGBTs. In this case, the number of items connected in series is 2. two (2). A maximum DC voltage U_{ZK} of 6.8 kV can occur between the DC potentials C and D. In a voltage intermediate circuit converter as shown in Figure 1, and having an input converter 2 according to the invention, the phase modules of the machine-side three-point pulse-controlled converter 14 are designed as shown in Figure 4, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 3.

[0015] ~~[0017]~~ Figure 5 shows a phase module whose in which the active converter devices T1 to T4 each have three semiconductor switches, in particular HV-IGBTs. The number of these active converter devices connected in series is three. WithIn this phase module, with three items connected in series, it is possible for a maximum DC voltage U_{ZK} of 10 kW to be dropped between or across the potentials C and D. In a voltage intermediate circuit converter for a standard medium voltage of 6 kV, the phase modules of the machine converter 14 are designed as shown in Figure 5, and the phase modules of

the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 4.

[0016] ~~[0018]~~ The number of items connected in series in the converter elements 4_1 and 6_1 in comparison to the number of items connected in series in the machine converter 14 is thus one less beyond a standard medium voltage of 3.3 kV. The phase modules of the converter elements 4_1 and 6_1 are therefore less complex than the phase modules in the machine converter 14. In a voltage intermediate circuit converter for the medium voltage of 4.16 kV, the number of semiconductor switches in the two converter elements 4_1 and 6_1 in the input converter 2 is equal to the number of semiconductor switches in the input converter 2 in the active front end embodiment. This means that, 5th, 7th, 17th and 19th harmonics are eliminated just by the circuitry, and without having to increase the number of semiconductor switches.

~~We~~WE Claim:CLAIM:

1. A voltage intermediate circuit converter ~~having~~comprising a 12-pulse input converter ~~which has~~having two converter elements, ~~having~~ a voltage intermediate circuit ~~which has~~having two capacitors ~~which are connected electrically in series, and having a~~ machine-side three-point pulse-controlled converter-(14), ~~with~~wherein the two converter elements of the input converter ~~being~~are electrically conductively connected on the DC-side to a respective capacitor in the voltage intermediate circuit, ~~characterized in that and~~ wherein the converter elements of the input converter have a respective self-commutated pulse-controlled converter.

2. The voltage intermediate circuit converter ~~as claimed in~~according to claim 1, ~~characterized in that~~wherein the self-commutated pulse-controlled converters are each three-point pulse-controlled converters.

3. The voltage intermediate circuit converter ~~as claimed in claims 1 and 2,~~ ~~characterized in that~~according to claim 1, wherein each capacitor in the voltage intermediate circuit is split ~~such that,~~ with one capacitor ~~is~~being associated with the machine-side three-point pulse-controlled converter, and two capacitors ~~are~~being associated with a pulse-controlled converter in the input converter.

4. The voltage intermediate circuit converter ~~as claimed in one of the above-mentioned claims, characterized in that~~ according to claim 1, further comprising a number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter ~~is~~and a number of series-connected active

converter devices in the machine-side three-point pulse-controlled converter, said number of active converter devices in the self-commutated pulse-controlled converter being equal to the number of series-connected active converter devices in the machine-side three-point pulse-controlled converter.

5. The voltage intermediate circuit converter ~~as claimed in one of claims 1 to 3, characterized in that~~according to claim 4, wherein the number of series-connected active converter devices in the self-commutated pulse-controlled converters in the input converter is one less than the number of series-connected active converter devices in the machine-side three-point pulse-controlled converter.

6. The voltage intermediate circuit converter ~~as claimed in one of the above-mentioned claims, characterized in that~~according to claim 4, wherein high-voltage insulated gate bipolar transistors are provided as active converter devices of the self-commutated pulse-controlled converters in the input converter and in the machine-side three-point pulse-controlled converter.

ABSTRACT

The invention relates to a voltage intermediate circuit converter having a 12-pulse input converter, having a voltage intermediate circuit and having a machine converter using three-point switching. According to the invention, the two converter elements of the input converter have a respective self-commutated pulse-controlled converter. An input converter is thus obtained, which links the advantages of a diode front end and an active front end with one another.

Description

Voltage intermediate circuit converter

5 The invention relates to a voltage intermediate circuit
converter as claimed in the precharacterizing clause of
claim 1.

A converter such as this is known from German magazine "etz", Issue 20, 1998, pages 10 to 12. This known voltage intermediate circuit converter has, in the standard version, a 12-pulse diode rectifier, whose diode rectifier elements are each connected to a secondary winding of a three-winding transformer. On the DC-side, the diode rectifier elements are each linked to a capacitor in a voltage intermediate circuit, which has two capacitors which are connected electrically in series. Such an input converter is also referred to as a diode front end (DFE). In most cases, such a diode front end satisfies the requirements for the mains system power factor and harmonic content. If mains feedback effects are subject to more stringent requirements, then a 24-pulse input converter is available.

25 A voltage intermediate circuit converter which has a
self-commutated pulse-controlled converter as the input
converter is known from German magazine "Engineering and
automation", Issue 1-2, 1998, pages 8 and 9. Like the
machine-side pulse-controlled converter, this is in the
30 form of a three-point pulse-controlled converter. The
voltage intermediate circuit is formed by two capacitors
which are electrically connected in series. This input
converter circuit option is also referred to as an active
front end (AFE). An active front end allows four-quadrant

131139	131138	131137	131136	131135	131134	131133	131132	131131	131130	131129	131128	131127	131126	131125	131124	131123	131122	131121	131120	131119	131118	131117	131116	131115	131114	131113	131112	131111	131110	131109	131108	131107	131106	131105	131104	131103	131102	131101	131100	131099	131098	131097	131096	131095	131094	131093	131092	131091	131090	131089	131088	131087	131086	131085	131084	131083	131082	131081	131080	131079	131078	131077	131076	131075	131074	131073	131072	131071	131070	131069	131068	131067	131066	131065	131064	131063	131062	131061	131060	131059	131058	131057	131056	131055	131054	131053	131052	131051	131050	131049	131048	131047	131046	131045	131044	131043	131042	131041	131040	131039	131038	131037	131036	131035	131034	131033	131032	131031	131030	131029	131028	131027	131026	131025	131024	131023	131022	131021	131020	131019	131018	131017	131016	131015	131014	131013	131012	131011	131010	131009	131008	131007	131006	131005	131004	131003	131002	131001	130999	130998	130997	130996	130995	130994	130993	130992	130991	130990	130989	130988	130987	130986	130985	130984	130983	130982	130981	130980	130979	130978	130977	130976	130975	130974	130973	130972	130971	130970	130969	130968	130967	130966	130965	130964	130963	130962	130961	130960	130959	130958	130957	130956	130955	130954	130953	130952	130951	130950	130949	130948	130947	130946	130945	130944	130943	130942	130941	130940	130939	130938	130937	130936	130935	130934	130933	130932	130931	130930	130929	130928	130927	130926	130925	130924	130923	130922	130921	130920	130919	130918	130917	130916	130915	130914	130913	130912	130911	130910	130909	130908	130907	130906	130905	130904	130903	130902	130901	130899	130898	130897	130896	130895	130894	130893	130892	130891	130890	130889	130888	130887	130886	130885	130884	130883	130882	130881	130880	130879	130878	130877	130876	130875	130874	130873	130872	130871	130870	130869	130868	130867	130866	130865	130864	130863	130862	130861	130860	130859	130858	130857	130856	130855	130854	130853	130852	130851	130850	130849	130848	130847	130846	130845	130844	130843	130842	130841	130840	130839	130838	130837	130836	130835	130834	130833	130832	130831	130830	130829	130828	130827	130826	130825	130824	130823	130822	130821	130820	130819	130818	130817	130816	130815	130814	130813	130812	130811	130810	130809	130808	130807	130806	130805	130804	130803	130802	130801	130799	130798	130797	13079
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operation (driving and regenerative braking in both
rotation directions). This

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active input converter not only allows a power factor of $\cos \phi = 1$ to be achieved, but also allows the wattless component

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of other loads to be compensated for in the mains system,
at least as far as power margins are concerned. If the
active front end is equipped with an input filter,
virtually harmonic-free operation from the mains system
5 is also possible.

A diode front end has the disadvantage that four-quadrant
operation is not possible without further complexity. The
additional complexity is that a break chopper is required
10 for generator operation, by means of which the generated
energy is converted into heat in a breaking resistance.
The use of 12-pulse and 24-pulse diode front ends means
that 5th, 7th, 11th and 13th harmonics, and 5th, 7th,
13th, 23rd and 25th harmonics, respectively, are
15 suppressed. In the 24-pulse embodiment of the diode front
end, the complexity on the input side is twice that of
the 12-pulse embodiment of the diode front end, which
means that it is not just the space requirement that
increases.

20 An active front end has the disadvantage that the 5th, 7th,
11th and 13th, etc. harmonics occur, depending on the
number of pulses, whose amplitudes, can at least be
minimized by means of an optimized pulse pattern.
25 Furthermore, the active front end is more complex than a
diode front end owing to the number and configuration of
the components. Since, in design terms, the active front
end corresponds to the machine-side self-commutated pulse-
controlled converter, a voltage intermediate circuit
30 converter with an active front end occupies a larger amount
of space than a voltage intermediate circuit converter with
a 12-pulse diode front end.

The invention is now based on the object of specifying a
35 voltage intermediate circuit converter whose input

converter is designed such that the harmonics which occur on the mains system side are kept as low as possible, with little complexity.

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This object is achieved according to the invention by the characterizing features of claim 1.

Since the converter elements of the 12-pulse input
5 converter are each self-commutated pulse-controlled
converters, the advantages of a diode front end are
combined with those of an active front end. This means
that the harmonic currents of the 5th, 7th, 17th and 19th
10 harmonics are suppressed on the mains system side of the
voltage intermediate circuit converter without the
optimized pulse patterns of the self-commutated pulse-
controlled converters being optimized to these said
harmonics. Since the two converter elements are in the
15 same operating state, their pulse patterns are the same.
This optimized pulse pattern can now be optimized such
that the amplitudes of the harmonic currents of the 11th,
13th, 25th, etc. harmonics are minimized.

A further advantage of this input converter according to
20 the invention for a voltage intermediate circuit
converter is evident at very high voltages. The
converters for standard medium voltages have two or more
active converter devices connected in series for a
voltage value above 3.3 kV. Since the input converter
25 according to the invention has two identical self-
commutated pulse-controlled converters, which are
connected electrically in series, the number of converter
elements connected in series is equal to or one less than
the number of machine converters connected in series.
30 With the standard medium voltage of 4.16 kV, the input
converter of a voltage intermediate circuit converter
according to the invention has precisely the same number
of active converter devices as an input converter in the
active front end configuration. Low blocking-capability
35 semiconductor switches, which can be operated at a higher

switching frequency or can be used at higher current levels, can be used as the active conductor

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Advantageous embodiments of the input converter can be found in the dependent claims 2 to 6.

5 In order to explain the invention in more detail, reference should be made to the drawing, which shows one embodiment of the input converter according to the invention, schematically, and in which:

10 Figure 1 shows a block diagram of a standard version of a voltage intermediate converter of this generic type,

15 Figure 2 shows a block diagram of an input converter according to the invention for a voltage intermediate circuit converter as shown in Figure 1, and

20 Figures 3-5 each show one phase module of a machine converter of a voltage intermediate circuit converter with 1, 2 and 3 items connected in series.

25 Figure 1 shows a block diagram of a standard version of a voltage intermediate circuit converter of this generic type with a 12-pulse input converter 2. The two converter elements 4 and 6 of this input converter 2 are each 6-pulse diode rectifiers. Each converter element 4 or 6 is linked on the DC-side to a respective capacitor 8 or 10 in a voltage intermediate circuit 12. Since these two
30 capacitors 8 and 10 are connected electrically in series, this voltage intermediate circuit 12 has three potentials C, M and D. Furthermore, this voltage intermediate circuit converter has a machine converter 14, to whose AC-side outputs R, S, T a three-phase machine 16 is
35 connected. On the DC-side, this machine converter 14 is

electrically conductively connected to the three potentials C, M and D of the voltage intermediate

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circuit 12. High-voltage insulated gate bipolar transistors (HV-IGBTs) are provided as active converter devices for the machine converter 14. The machine converter 14 uses three-point switching. The converter
5 elements 4 and 6 of the input converter 2 are

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electrically conductively connected on the AC-side to a respective secondary winding 18 or 20 of a three-winding transformer 22. On the primary side, this three-winding transformer 22 is linked to a three-phase mains system 24.

Figure 2 shows a block diagram of an advantageous embodiment, according to the invention, of an input converter 2. This input converter 2 has respective self-commutated pulse-controlled converters 4_1 and 6_1 as the converter elements 4 and 6, respectively. These two pulse-controlled converters 4_1 and 6_1 use three-point switching in the same way as the machine-side three-point pulse-controlled converter 14, with HV-IGBTs likewise being used as the active converter devices. On the AC-side, the connections U1, V1, W1 of the self-commutated pulse-controlled converter 4_1 are linked to the secondary winding 18 of the three-winding transformer 22. On the AC-side, the connections U2, V2, W2 of the self-commutated pulse-controlled converter 6_1 are connected to the secondary winding 20 of the three-winding transformer 22.

This illustration in Figure 2 also shows the voltage intermediate circuit 12 in more detail. The two capacitors 8 and 10 of this voltage intermediate circuit 12 are each subdivided into three capacitor elements 8_1 , 8_2 , 8_3 and 10_1 , 10_2 , 10_3 . In this case, the two capacitor elements 8_2 , 8_3 and 10_2 , 10_3 are connected electrically in series, and this series circuit is then connected electrically in parallel with the respective capacitors 8_1 and 10_1 . The junction point between the two series-connected capacitors 8_2 , 8_3 and 10_2 , 10_3 form a medium-voltage potential M1 or M2, respectively, for the respective three-point pulse-controlled converters 4_1 and

6₁. These two series circuits of capacitor elements 8₂, 8₃ and 10₂, 10₃ are also connected electrically in series. The junction point between

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these two series circuits is connected to the central voltage M of the voltage intermediate circuit 12. Since the capacitors 8 and 10 in the voltage intermediate circuit 12 are each subdivided into a number of capacitor elements 8₁, 8₂, 8₃ and 10₁, 10₂, 10₃,

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the capacitor elements 8_1 and 10_1 can be physically associated with the machine converter 14, and the capacitor elements 8_2 , 8_3 and 10_2 , 10_3 can be physically associated with the self-commutated pulse-controlled converter 4_1 , 6_1 in the input converter 2.

Figure 3 shows a phase module of the machine converter 14, which has four active converter devices T1, T2, T3 and T4 using three-point switching. Each active converter device T1 to T4 has only one semiconductor switch, in particular an HV-IGBT. The number of series connected items in this embodiment is therefore one. This phase module can accommodate a maximum DC voltage U_{ZK} of 3.8 kV between its DC potentials C and D. This DC voltage U_{ZK} is produced by the input converter 2. Since the two converter elements 4_1 and 6_1 are identical and are connected electrically in series on the DC-side, each converter element 4_1 and 6_1 produces half the intermediate circuit voltage U_{ZK} , amounting to 1.9 kV. However, since the phase module has twice the withstand voltage, low blocking-capability semiconductor switches can be used, in comparison to the phase module of the machine-side three-point pulse-controlled converter 14. These low blocking-capability HV-IGBTs can be operated at a higher switching frequency, or at a higher current level.

Figure 4 shows a phase module, whose active converter devices T1 and T4 each have two semiconductor switches, in particular HV-IGBTs. In this case, the number of items connected in series is 2. A maximum DC voltage U_{ZK} of 6.8 kV can occur between the DC potentials C and D. In a voltage intermediate circuit converter as shown in Figure 1, having an input converter 2 according to the invention, the phase modules of the machine-side three-

point pulse-controlled converter 14 are designed as shown in Figure 4, and the phase modules of the

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converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 3.

Figure 5 shows a phase module whose active converter
5 devices T1 to T4 each have three semiconductor switches,

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in particular HV-IGBTs. The number of these active converter devices connected in series is three. With this phase module, with three items connected in series, it is possible for a maximum DC voltage U_{zk} of 10 kW to be dropped between or across the potentials C and D. In a voltage intermediate circuit converter for a standard medium voltage of 6 kV, the phase modules of the machine converter 14 are designed as shown in Figure 5, and the phase modules of the converter elements 4_1 and 6_1 in the input converter 2 are designed as shown in Figure 4.

The number of items connected in series in the converter elements 4_1 and 6_1 in comparison to the number of items connected in series in the machine converter 14 is thus one less beyond a standard medium voltage of 3.3 kV. The phase modules of the converter elements 4_1 and 6_1 are therefore less complex than the phase modules in the machine converter 14. In a voltage intermediate circuit converter for the medium voltage of 4.16 kV, the number of semiconductor switches in the two converter elements 4_1 and 6_1 in the input converter 2 is equal to the number of semiconductor switches in the input converter 2 in the active front end embodiment. This means that, 5th, 7th, 17th and 19th harmonics are eliminated just by the circuitry, without having to increase the number of semiconductor switches.

Patent Claims

1. A voltage intermediate circuit converter having a 12-pulse input converter (2) which has two converter elements (4, 6), having a voltage intermediate circuit (12) which has two capacitors (8, 10) which are connected electrically in series, and having a machine-side three-point pulse-controlled converter (14), with the two converter elements (4, 6) of the input converter (12) being electrically conductively connected on the DC-side to a respective capacitor (8, 10) in the voltage intermediate circuit (12), characterized in that the converter elements (4, 6) of the input converter (12) have a respective self-commutated pulse-controlled converter (4₁, 6₁).
2. The voltage intermediate circuit converter as claimed in claim 1, characterized in that the self-commutated pulse-controlled converters (4₁, 6₁) are each three-point pulse-controlled converters.
3. The voltage intermediate circuit converter as claimed in claims 1 and 2, characterized in that each capacitor (8, 10) in the voltage intermediate circuit (12) is split such that one capacitor (8₁, 10₁) is associated with the machine-side three-point pulse-controlled converter (14), and two capacitors (8₂, 8₃; 10₂, 10₃) are associated with a pulse-controlled converter (4₁, 6₁) in the input converter (12).

4. The voltage intermediate circuit converter as claimed in one of the abovementioned claims,

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characterized
in that the number of series-connected active
converter devices (T1, T2, T3, T4) in the self-
commutated pulse-controlled converters (4₁, 6₁) in
5 the input converter (12) is equal to the number of
series-connected active converter devices (T1, T2,
T3, T4) in the machine-side three-point pulse-
controlled converter (14).

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5. The voltage intermediate circuit converter as claimed in one of claims 1 to 3, characterized

5 in that the number of series-connected active converter devices (T1, T2, T3, T4) in the self-commutated pulse-controlled converters (4₁, 6₁) in the input converter (12) is one less than the number of series-connected active converter devices (T1, T2, T3, T4) in the machine-side three-point pulse-controlled converter (14).

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6. The voltage intermediate circuit converter as claimed in one of the abovementioned claims, characterized

15 in that high-voltage insulated gate bipolar transistors are provided as active converter devices (T1, T2, T2, T4) of the self-commutated pulse-controlled converters (4₁, 6₁) in the input converter (12) and in the machine-side three-point pulse-controlled converter (14).

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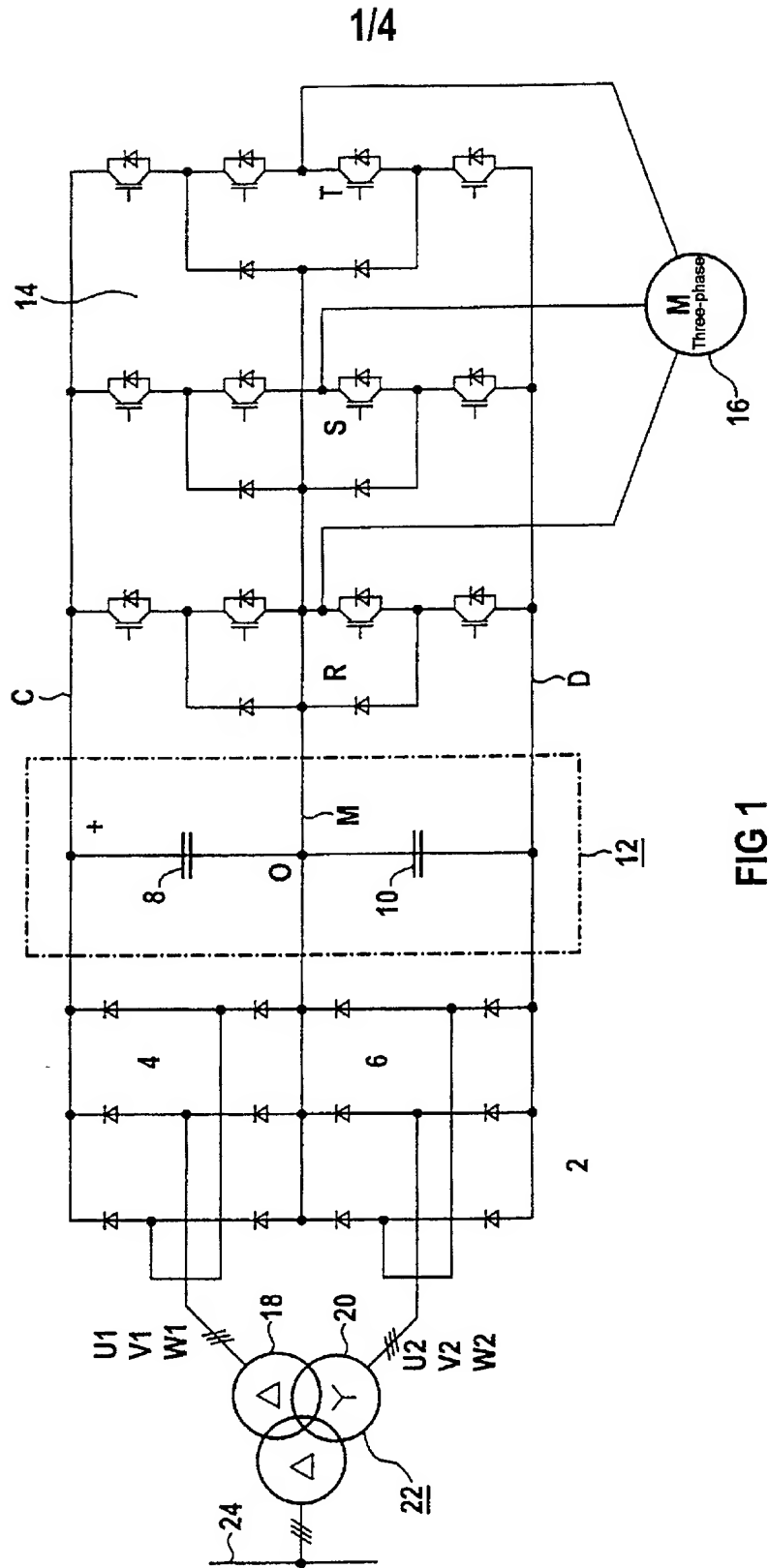
Abstract

Voltage intermediate circuit converter

The invention relates to a voltage intermediate circuit converter having a 12-pulse input converter (2), having a voltage intermediate circuit (12) and having a machine converter (14) using three-point switching. According to the invention, the two converter elements (4, 6) of the input converter (2) have a respective self-commutated pulse-controlled converter (4_1 , 6_1). An input converter (2) is thus obtained, which links the advantages of a diode front end and an active front end with one another.

FIG 2

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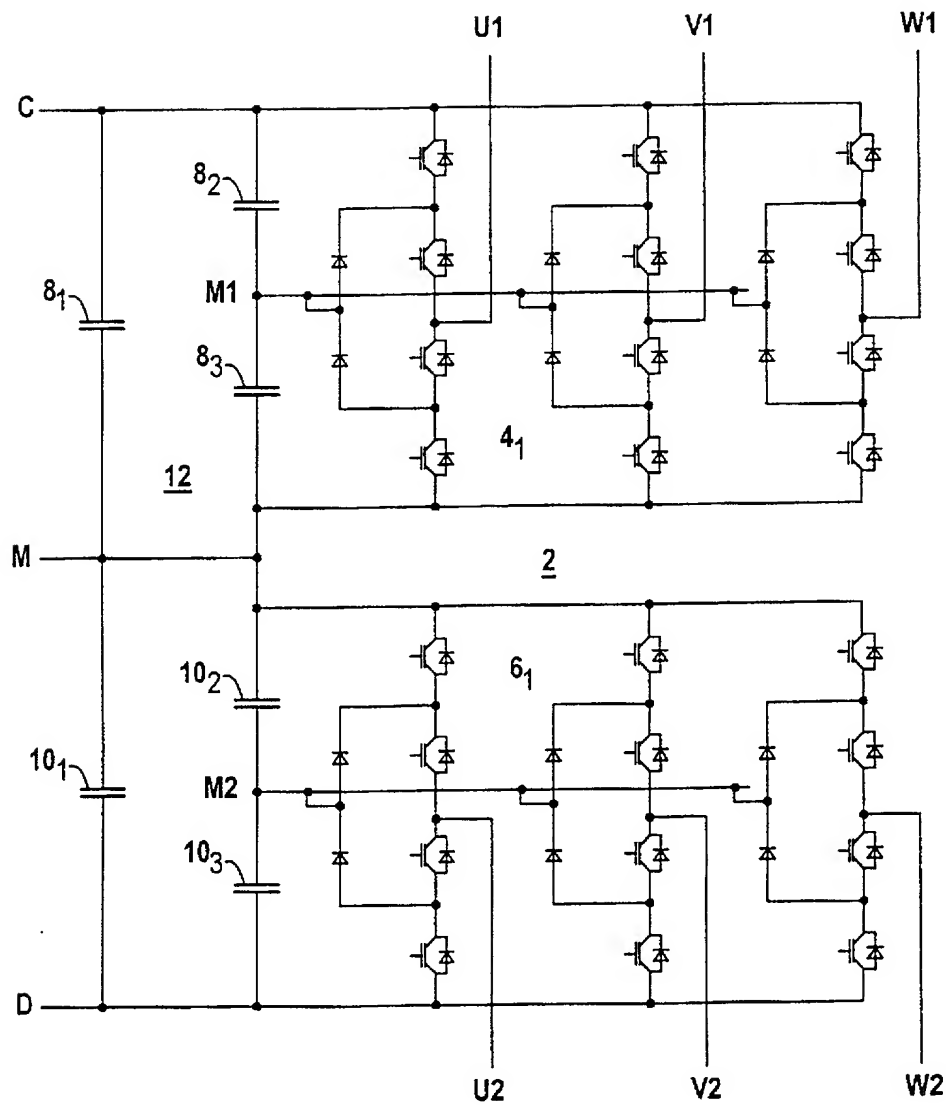
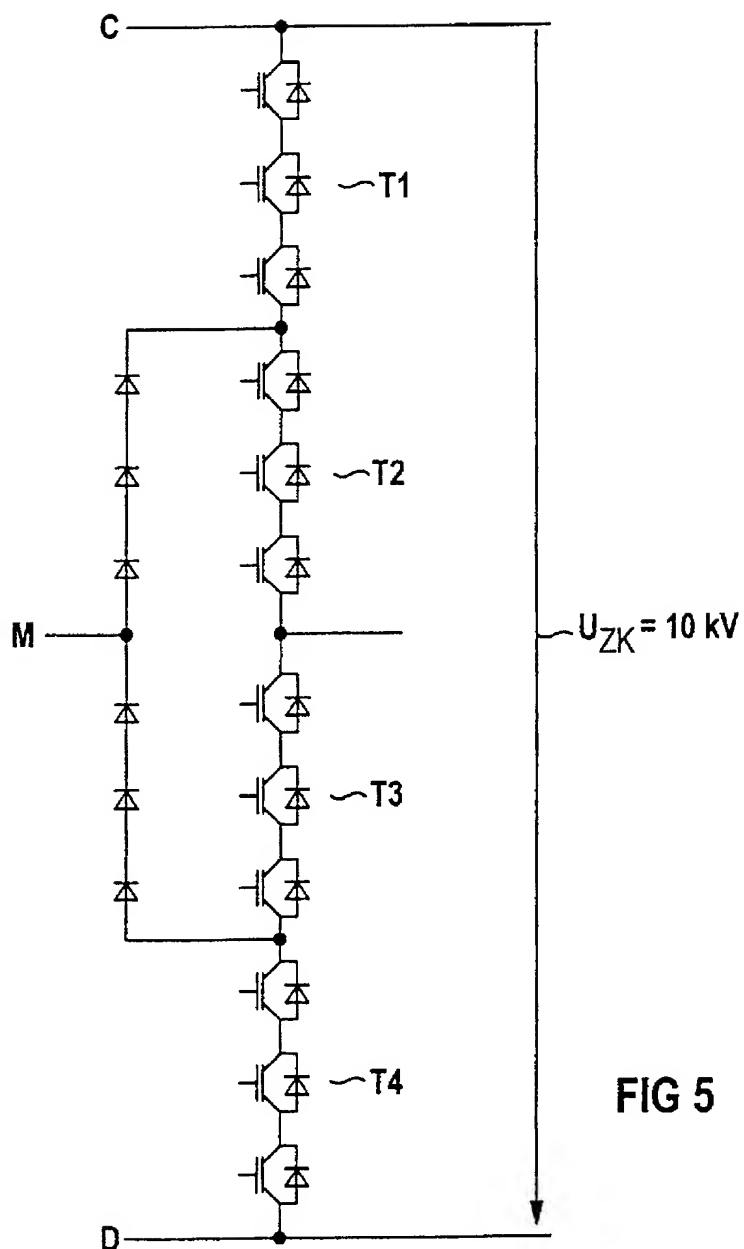


FIG 2



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O I P E J C I E I
 MAR 29 2002
 PATENT MARK OFFICE

German Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Indirect Voltage Converter

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 07.06.2000 as

PCT international application

PCT Application No. PCT/DE00/01847

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

19926979.3

DE

14.06.1999

☒

☐

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

Yes
Ja

No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

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(Nummer)

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(Land)

(Day Month Year Filed)
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☐
No
Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

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PCT/DE00/01847

(Application Serial No.)
(Anmeldeseriennummer)

07.06.2000

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

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(Status)
(patentiert, anhängig,
aufgegeben)

(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

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Unterschrift des Erfinders	Datum	Inventor's signature	Date
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(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

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